Remarks

Claims 1-5, 7-12, 14-17, and 19-24 are pending and claims 1-5, 7-12, 14-17, and 19-23 stand rejected. Claim 24 is withdrawn from consideration. Claims 5 and 19 are cancelled without prejudice by this amendment. Claims 1-4, 7-12, 14-17, and 20-23 are amended by this amendment. Applicants respectfully traverse the rejection and request allowance of claims 1-4, 7-12, 14-17, and 20-23.

Applicants provisionally elected claims 1-23 during a phone conversation with the Examiner. Responsive to section 1 of the 3-14-01 office action, Applicants formally elect claims 1-23 in this response.

Responsive to section 2, applicants submit that the producing well is a conventional feature, and therefore does not have to be shown in the drawings. The important feature of claim 11 to understand the invention is the circuitry configured to close a valve. The important feature of claim 12 is the means for indicating an alarm. These features are clearly shown in FIG. 8 and described in the specification.

Responsive to section 3, Applicants amended the specification to correct the informalities listed. For the informality of a "producing well", see the argument in the above paragraph.

Responsive to section 4, Applicants amended the title. Also, the amendments that Applicants made to the claims render the rejections in sections 5-8 moot.

Examiner rejected claim 1 as being anticipated by U.S. Patent 5,295,084 (Arunachalam) in sections 9-10. Arunachalam teaches electronics that determine density measurements from signals received from a Coliolis flowmeter (column 7, lines 12-21). The electronics in Arunachalam monitor how the natural frequency of the flowtube changes as the mass flow rate through the flow tube changes (column 8, line 51 through column 9, line 57; FIG. 3). The electronics adjust the natural frequency to compensate for the frequency change due to the mass flow rate through the flow tube (Id.). The electronics also adjust the natural frequency to compensate for temperature (Id.). The electronics then use the adjusted natural frequency to calculate a density for the fluid flowing through the flow tube (Id.).

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Conversely, claim 1 describes a flowmeter comprised of a flow tube, a driver, pickoffs, and meter electronics. The meter electronics determines a density of a material flowing through the flowtube based on a pickoff signal from one of the pickoffs. The meter electronics monitors a drive gain of the flow tube for a change in value to determine if the material flowing through the flowtube comprises a multiphase flow. If the material flowing through the flowtube does comprise a multiphase flow, then the meter electronics determines the density of the material based on stored density values.

Arunachalam does not teach "monitoring a drive gain ... to determine if the material ... comprises a multiphase flow." Arunachalam does not even mention multiphase flow or how to handle them. In fact, Arunachalam only discusses fluids that have constant densities (column 9, line 67 to column 10, line 1). The very problem being solved by claim 1 is that multiphase flows have changing densities. Arunachalam also does not teach "determining said density...based on a stored density value" if the material flowing through the flowtube comprises a multiphase flow. Therefore, claim 1 is allowable over Arunachalam.

The Examiner also rejected claim 1 as being anticipated by U.S. Patent 6,092,409 (Patten) in sections 11-12. Patten teaches processes for checking the accuracy of a flowmeter (column 2, lines 30-39). The processes retrieve known values from memory, such as known densities, deviation ranges, periods of oscillation (column 8, lines 54-67; column 9, lines 11-35; column 9, line 54 to column 10, line 9). The processes compare the known values to values measured from the flowmeter (Id.). Differences in the known values and measured values are used to determine the accuracy of the flowmeter (Id.).

Patten does not teach "monitoring a drive gain ... to determine if the material ... comprises a multiphase flow." Patten also does not teach "determining said density...based on a stored density value" if the material flowing through the flowtube comprises a multiphase flow. The known values in Patten all assume a fixed density of the material flowing through the flowmeter. If the processes were used on a flowmeter measuring a multiphase flow, then the processes would indicate that the flowmeter is inaccurate. In reality, the density changes would be due to the multiphase flow and not the accuracy of the flowmeter. Therefore, claim 1 is

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allowable over Patten. Claim 14 is also allowable for similar reasons. Claims 2-4, 7-12, 15-17, and 20-23 are allowable as being dependent on claim 1 or 14.

Applicants submit that there may be additional reasons in support of patentability, but that such reasons are moot in light of the above remarks and are omitted in the interests of brevity. Applicants respectfully request allowance of claims 1-4, 7-12, 14-17, and 20-23.

Respectfully submitted,

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Version with Markings to Show Changes Made

In the Specification

The following represent marked-up versions of the amendments made to the specification.

In the paragraph on page 8, beginning on line 5:

FIG. 3 depicts an undamped dynamic spring assembly 300 that operates on the same physical principles as flowtubes 103A and 103B of Coriolis flowmeter 5 (see FIG. 1) in single phase flow. Spring 302 is connected to an anchor 304 and a mass 306. The mass 306 reciprocates or vibrates on a path parallel to double headed arrow 308. The natural frequency, f_n of assembly 300 is:

$$f_n = \frac{1}{2\pi}\sqrt{\frac{K_s}{m}} \qquad (1)$$

where K_s is the spring constant of spring 302 and m is the mass of mass 306. In the case of Coriolis flowmeter 5, m is the combined weight of the flowtubes 103A and 103<u>B</u> together with the mass of material inside the tubes.

In the paragraph on page 9, beginning on line 11:

FIG. 4 depicts a damped dynamic spring and mass assembly 400 that operates on the same physical principles as flowtubes 103 A and 103 B of Coriolis flowmeter 5 (see FIG. 1) in multiphase phase flow including gas and liquid. Where possible, like numbering in FIG. <u>3</u> [4] has been retained for identical elements in FIG. 4. FIG. 4 differs from FIG. 3 by the addition of a damper 402, which has the effect of reducing the amplitude of vibration along path 308. Equations (1) and (2) still apply to the system shown in FIG. 4, but the overall magnitude of vibration is less due to damper 402.

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In the paragraph on page 11, beginning on line 3:

The effects shown in FIGS. 5-6 [5-7] are similar to the effects of multiphase flow including liquids and solids, e.g., with paraffin, sand, or scale in the fluid, or with scale having actually built up on the internal flowtube walls of flowtubes 103A and 103B. Thus, a system capable of detecting gas and liquid multiphase flow is also capable of detecting, using the same principles, multiphase flow including gas and solids, liquid and solids or scale internal to the flowtubes.

In the paragraph on page 14, beginning on line 7:

As shown in FIG. 8, a schematic block diagram, system 800 includes a manifold 802 having a plurality of electronically actuated wellhead valves 803, 803', and 803" that each provide multiphase flow including gas, liquid and solids to tubing 804. Valves 803, 803' and 803" are preferably three-way electronically-initiated, pneumatically actuated valve, such as the Xomox TUFFLINE 037AX WCB/316 well switching valve with a MATRYX MX200 actuator. Valves 803, 803' and 803" are selectively configured to provide multiphase flow from one well at a time through manifold 802 and tubing [test line] 804 to Coriolis flowmeter 806, which may be the same as Coriolis flowmeter 5. Coriolis flowmeter 806 measures the volumetric flow rate of one of the wells connected to valves 803, 803', or 803". [The well connected via valves 803, 803', and 803" flowing through Coriolis flowmeter 806 is under test for its volumetric flow rate to determine its] The volumetric flow rate of the well helps to determine the contribution of this particular well to total sales. The remainder of material from the other wells [flow-through] connected to valves 803, 803', and 803" flow through to line 808 for passage through second meter 810, which may be a sales meter. Flow through Coriolis flowmeter 806 discharges into meter discharge line 812 and enters water cut meter 812. The flow is thereafter combined with the flow in gathering line 808 for measurement through second meter 810. Exemplary forms of flowmeters 806 and 810 include the ELITE Models CMF300356NU and Model CMF300H551NU, which are available from Micro Motion of Boulder, Colorado.

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In the paragraph on page 15, beginning on line 12:

System 800 operates as follows. Manifold 802 carries [cause] a material from single valve [well] 803, 803' or 803" to flow through Coriolis flowmeter 806 to test a [the] well or provide mass flow rate information concerning a [the] well connected to the single valve 803, 803', or 803". The material flowing through the remaining valves 803, 803', or 803" [while the remainder of the wells] flow into gathering line 808 for combined sales output through second meter 810. Coriolis flowmeter 806 provides density and mass flow rate information as meter outputs to transmitter 824 which, in turn, provides signals to controller 818 on lead 822. One of computer 816, controller 818, transmitter 824 or Coriolis flowmeter 806 (typically computer 816) performs a calculation for total volumetric flow rate Q_e according to Equation (4):

$$Q_e = \frac{M_e}{D_e} \tag{4}$$

wherein M_e [D_e] is a Coriolis-based mass flow rate measurement obtained from the total combined oil and water flow stream; and D_e is a density of the total combined oil, gas, water and solids flow stream at a measurement temperature T.

In the paragraph on page 16, beginning on line 7:

The volumetric flow rate values Q_o and Q_w can be corrected to a standard reference temperature, T_{ref} [T_r], through multiplication of the volumetric flow rate values by the density at a measurement temperature and dividing by the density at the reference temperature, e.g., as in Equation (7):

$$Q_o = Q_{o,T} * \frac{D_{O,T}}{D_O} \tag{7}$$

wherein Q_o is a volumetric oil flow rate at a standard reference temperature T_{ref}; $Q_{o,T}$ is a volumetric oil flow rate measured at temperature T and calculated according to Equation (5); Do is a measured density of oil from laboratory measurements at reference temperature T_{ref}; and $D_{o,T}$ is a density of oil measured at temperature T.

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